

Meaning of Derivative

The derivative of function $f(x)$ at $x = c$ is the *instantaneous rate of change* of $f(x)$ with respect to x at $x = c$. It is found

- numerically, by taking the *limit* of the average rate over the interval from c to x as x approaches c
- graphically, by finding the slope of the line tangent to the graph at $x = c$

Find an estimate for the derivative of $f(x) = 2^x(5-x)$ at $x = 1$

Store the function in Y1

```
P1to1 P1to2 P1to3
Y1= 2^X(5-X)
Y2=
Y3=
Y4=
Y5=
Y6=
Y7=
```

Store a small value of H on the home screen.

Set up $(Y1(1+H) - Y1(1))/H$ on the home screen.

Store increasingly small values of H and evaluate the difference quotient each time, watching the values of the difference quotient reach a limit.

$$f'(1) \approx 1.545$$

```
H 1.54514895
.0000001→H 1E-7
(Y1(1+H)-Y1(1))/H
H 1.545176
```

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EXAMPLE 2

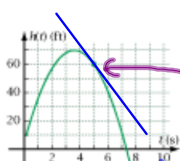


Figure 1-2b

Figure 1-2b shows the graph of a function that could represent the height, $h(t)$, in feet, of a soccer ball above the ground as a function of the time, t , in seconds since it was kicked into the air.

- Estimate the instantaneous rate of change of $h(t)$ at time $t = 5$.
Estimate the slope of the tangent line
- Give the mathematical name of this instantaneous rate, and state why the rate is negative.

The mathematical name is the derivative and it is negative when $x = 5$ because the height is decreasing as time increases

EXAMPLE 3

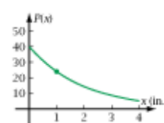


Figure 1-2d

Figure 1-2d shows a graph of $P(x) = 40(0.6^x)$, the probability that it rains a number of inches, x , at a particular place during a particular thunderstorm.

- The probability that it rains 1 inch is $P(1) = 24\%$. By how much, and in which direction, does the probability change from $x = 1$ to $x = 1.1$? What is the average rate of change from 1 inch to 1.1 inches? Make sure to include units in your answer. Why is the rate negative?

Aug 20-8:08 AM

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